LIGHT-SCATTERING STUDIES IN SOLUTIONS OF ACACIA CATECHUIC ACID

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ABSTRACT The effects of addition of neutral salts like KCl, NaCl, $BaCl_2$ and AlCl on the light scattering properties of Acacia Catechuic Acid have been reported. In all case the cations appeared to have marked influence in reducing the intramolecular repulsion. The behaviour was analogous as observed with the valency rule. The behaviour of aluminium was, however, slightly different probably due to marked hydrolysis of aluminium salt. Although there was variation in the root mean square end to end distance in different case the molecular weight more or less appeared to remain almost constant, i.e., about 5×10^6.

INTRODUCTION

Acacia Catechuic Acid (ACA) is a gum acid obtained by the electrodialysis of gum catechu and replacement of the cations by hydrogen ions. Previous investigations (Kubshrestho et al, 1962; Chakraborty et al, 1963), of this gum acid revealed its polyelectrolytic behaviour. In the present communication, this property of ACA has been tested further and its physico-chemical behaviour with respect to the addition of neutral salts having cations of different valencies has been investigated with the help of light-scattering method.

EXPERIMENTAL

Weighed quantities of ACA were taken and required quantities of NaOH solutions were added to each for their complete neutralisation. They were next dissolved in 0.025*N* KCl solution by shaking and then allowed to settle for about 24 hours. Both catechuic acid solution and 0.025*N* KCl solution were made dust free by repeated filtration through G_4 sintered glass filters. Scattering measurements were made at angles $-45°$, $-90°$, $-135°$ and $0°$ in a Brice Phonix Light Scattering Photometer using a semi-octagonal dissymmetry cell.

The net values of turbidity and dissymmetry were calculated after subtracting the values obtained for the solvent in each case. The specific refractive increments were determined by means of a Brice Phoenix Differential Refractometer maintaining a temperature of 28°C.

All the above mentioned steps were repeated while examining the light scattering behaviour of ACA in presence of 0.025*N* NaCl, 0.01*N* $BaCl_2$ and 0.0039N $AlCl_3$ respectively.

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DISCUSSION

The molecular weight M was calculated from the Debye (1947) equation

$$\frac{HC}{\tau} P(90) = \frac{1}{M} + 2BC \cdot P(90)$$

where

$$H = \frac{32\pi^3 n_0^2 (n-n_0)^2}{3N\lambda^4 C^2}$$

C is the concentration of the solution in gm/ml, B, the interaction constant, n, the refractive index of the solution n_0, that of the solvent, λ, the wavelength of the incident light in cm, N_0, the Avogrado number, τ, the absolute turbidity of the solution in excess of that of the solvent, $(n-n_0)$, the refractive increment of the solution in excess of the solvent and P(90), the particle scattering factor at 90° angle.

To examine the effect of monovalent, divalent and trivalent ions on ACA, the light scattering measurements were performed with chlorides of Sodium (and Potassium), Barium and Aluminium. The linear graphs of HC/T vs. C (Fig. 1)

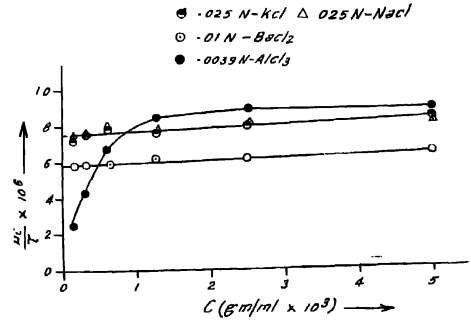

Fig. 1. Variation of HC/τ with Concentration

resulted in each case with NaCl, KCl and $BaCl_2$ solutions. The graphs corresponding to NaCl and KCl solutions overlapped each other showing the identity of the effects of sodium and potassium upon the scattering behaviour of ACA. The slope obtained was very small which indicated negligible interactions between the ACA molecules. The molecular weight from this plot comes out to be 5.04×10^6 after making necessary corrections for the dissymmetry of scattering. The depo-

larisation effect in all these experiments were found to be very small and no correction was considered necessary.

The plot of $\frac{HC}{\tau}$ vs C with 0 01N $BaCl_2$ solution almost ran parallel to that obtained with 0.025N NaCl or KCl solution which shows that the interaction constants of ACA in presence of these salts are of the same order of magnitude. The molecular weight from this intercept comes out to be 4.7×10^6 after making all corrections as usual.

The behaviour of aluminium was slightly different probably due to marked hydrolysis of aluminium salts. The non-linear plot of $\frac{HC}{\tau}$ vs. C for $AlCl_3$ solution involved a little uncertainty in the determination of the molecular weight. However, if the molecular weight is calculated from the linear portion of the plot neglecting the points in the very dilute region, its value remains almost the same.

Let us now confine our attention to the plots of Z (dissymmetry) vs C (Fig. 2) fo ACA solutions in presence of the above mentioned salts It appears that the

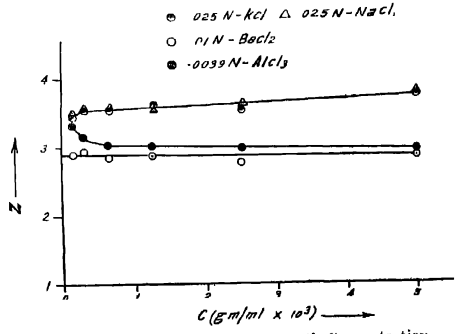

Fig. 2. Variation of Dissymetry with Concentration.

intrinsic dissymmetry of ACA is 3.5 in 0.025N NaCl and KCl solution, 2.9 in 0.01 N $BaCl_2$ solution and 3.05 in 0.0039N $AlCl_3$ solution which refers to a root-mean-square end to end distance of the polymeric coil as 305 2 $m\mu$, 252 9 $m\mu$ and 266$m\mu$ respectively as against 327 $m\mu$ in pure water. (Chakraborty *et al.* 1963).

The low values of rms end to end distance of ACA, determined from measurements in the salt solutions indicate that a high contraction in the size of the macromolecule takes place in the presence of gegen ions. In the salts, the gegen ions present screen the charged groups and repulsion between them becomes less; under these conditions the molecule undergoes contraction.

It was, however, noted that the barium ion was more effective than Na or K ions in their screening action because the contraction produced by 0.01N $BaCl_2$ solution was greater than that produced by 0 025N Kcl or NaCl solution. It was interesting to note that although the strength of the $AlCl_3$ solution was less than half the strength of $BaCl_2$ solution, yet their intrinsic dissymmetry values were only slightly different. Hence it appeared that in all the cases, the cations had marked effects in diminishing the intramolecular coulombic repulsion and the behaviour was almost analogous as observed with valency rule.

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